Annals of Clinical and Analytical Medicine
Original Research

Could the subvastus approach be the first choice in total knee arthroplasty?

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Abstract

Aim: Total knee replacement procedures are widely used in advanced cases of knee osteoarthritis. Medial parapatellar arthrotomy is one of the most commonly used approaches in total knee replacement. As an alternative to this approach, the subvastus approaches have been developed. The purpose of this study is to compare medial parapatellar and subvastus approaches.

Material and Methods: The study population was the archive of the orthopedics and traumatology clinic of a third-level hospital. This is a retrospective study. The study was conducted with 288 participants, including 147 MPPs and 141 SV. Range of motion, pain scores, and functional scores of the patients were recorded. The GENESIS II TKR system was performed for all participants.

Results: No significant difference was observed in terms of age, BMI values, and the operated side among the patients. No significant difference was found in KSS values between groups at the 12th week and first-year measurements. However, there were statistically significant differences observed in OKS measurements on the third and tenth days. A significant difference was observed in VAS values measured on the first and third postoperative days. The study groups were analyzed in terms of developing complications. According to the findings, no complications were observed in 136 participants in the MPP group and 129 participants in the SV group.

Discussion: Our study concluded that the SV approach should not be the first choice for TKR due to its limitations.

Keywords

Total Knee Replacement, Medial Parapatellar Arthrotomy, Subvastus Approach, Continuous Passive Motion, Range of Motion, Visual Analogue Scale

DOI: 10.4328/ACAM.21759 Received: 2023-05-17 Accepted: 2023-06-20 Published Online: 2023-08-08 Printed: 2023-11-01 Ann Clin Anal Med 2023;14(11):1006-1010
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This study was approved by the Ethics Committee of Kirsehir Ahi Evran University (Date: 2023-03-07, No: 2023-05/30)

Introduction

Total knee replacement (TKR) procedures are widely used in advanced cases of knee osteoarthritis [1]. The literature reports survival rates of over 20 years, in the range of 90-95% [2]. Cost-effectiveness studies have shown that TKR procedures are cost-effective, and numerous studies have been conducted in this regard [3,4]. Accelerating the return to normal life is the primary goal in current TKR procedures. The economic and social impacts of this goal have been investigated, and the effectiveness of different protocols has been compared [5]. The goal is to reduce hospitalization time to hasten the return to normal life and facilitate early rehabilitation is the objective [6]. Complications that develop after TKR have been the subject of numerous studies. Severe pain and decreased strength in the quadriceps muscles are among the most common complications. It has been reported that the traditional medial parapatellar arthrotomy (MPP), which involves detachment of the medial portion of the quadriceps tendon from the patella, leads to painful scar tissue [7].

However, there is information indicating that this approach may cause damage to the quadriceps tendon and delay rehabilitation [7]. As an alternative to this approach, the subvastus approach (SV) has been developed. Early functional outcomes have been reported to be better with the SV approach. Different approaches have yielded varying results in the literature [8-12]. In the SV approach, the muscle incision is small, making it difficult to visualize the surgical area. As a result, difficulties in exposure are encountered, and the risk of injury to the patient remains uncertain [8].

The purpose of this study is to compare patients who underwent surgery using the minimally invasive SV and MPP approaches at our clinic.

Material and Methods

Study Population

The study population consisted of an archive of total knee arthroplasties.

Study Design and Participants

Our study was retrospective. A total of 380 patients who underwent total knee arthroplasty in the orthopedics and traumatology clinic between June 2019 and January 2022 were included in the study. Participants were selected using the SV or MPP approach and were followed up for at least one year. Participants were selected according to standard protocols, and those who did not meet the criteria were excluded from the study. The study was conducted with 288 participants, including 147 MPPs and 141 SV, with complete medical records. One week before the operation, physical examinations were performed after preoperative anesthesia examination. The participants' demographic information, implant selection, and measurement planning were recorded before the operation.

One day prior to surgery, the range of motion (ROM), pain scores (VAS), and functional scores (KSS, OKS) of patients were recorded. Informed consent was obtained from the participants. Following standard inpatient evaluations on the first, second, and third days of the post-op period, outpatient follow-up evaluations were conducted on the 10^{th} day, 20^{th} day, sixth week, third month, sixth month, and the first year. Standard follow-ups were continued annually. On the first day after surgery, rehabilitation was initiated with the device adjusted to 45°. For those who tolerated the rehabilitation for 60 minutes, the device was adjusted to 75°, 90°, 105°, and 120°, respectively. Permission was granted up to 90° on the first day, and those who tolerated it were allowed to progress to 105° and 120° on the second day. The angle that participants could tolerate and the duration of their tolerance was recorded on the first, second, and third days.

Groups

- Group 1 refers to the MPP approach.
- Group 2 refers to the SV approach.

Surgical technique

MPP Approach

The GENESIS II TKR system (Smith & Nephew; Memphis, TN) was applied to all participants following standard femoral and tibial cuts. The arthrotomy was initiated five mm lateral to the vastus medialis muscle of the joint capsule and three cm above the patella and completed by leaving a five mm tissue layer between the patella and the capsule.

SV Approach

Smith and Nephew, Genesis II implantation was performed for all participants following standard femoral and tibial cuts. The posteromedial border of the vastus medialis muscle was identified by finger dissection, separated by blunt dissection, and elevated with a periosteal elevator. From the point where the muscle meets the patella, arthrotomy was initiated from the medial side, leaving approximately five millimeters away. The arthrotomy was then completed at the level of the tibial tuberosity, following the medial aspect of the patellar tendon.

Data

The research data were as follows:

-Age, BMI values, and the side on which the surgery was performed.

-Soft tissue complications have been recorded, including superficial infections, deep joint infections, hematomas, tissue degradation, and their timing and treatment processes.

-Continuous Passive Motion (CPM).

-Opioid consumption was recorded on the first day of the postoperative period, on the first, second, and third days of hospital stay, and when the first opioid need occurred.

-Visual Analogue Scale (VAS) values were measured on preoperative, postoperative first, third, and tenth days, 12th week, and the first year.

-Rehabilitation parameters were measured, including Knee Society Score (KSS) and Oxford Knee Score (OKS), at preoperative and on the postoperative 10th day and 12th week.

-Range of Motion (ROM) was measured on preoperative, postoperative third day, 10th day, 12th week, and first year.

Ethics

Ethical permissions for the study were obtained from the ethics committee of the tertiary healthcare institution where the researchers work (Date: 07 March 2023 / 2023-05/30)

Power Analysis

A power analysis was performed to determine the sample size. An effect size of d=0.75, Power(1-β)=0.90 and allocation ratio 1 were assumed. As a result, the minimum sample size was calculated as 39 people in each group.

Statistical Analysis

Analyses were conducted using SPSS 26 software. The normality of the data was examined using the Kolmogorov-Smirnov test. The Mann-Whitney U test was utilized to compare two independent groups, whereas the Friedman test was used for repeated measurements of more than two groups. In case of significant differences, Bonferroni-corrected p-values were considered in multiple comparisons. Relationships between categorical variables were examined using Chi-square tests. A significance level of $p < 0.05$ was deemed statistically significant in all analyses.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

According to research groups, no significant difference was observed in terms of age, BMI values, and the operated side among the patients (p>0.05). However, significant differences were identified between the ROM values measured on the third and tenth days after surgery (p<0.05). Upon examination of the findings, it was determined that the mean of the SV group was higher than the mean of the MPP group on both days

No significant difference was found in KSS values between groups at the 12th week and first-year measurements. However, there were statistically significant differences observed in OKS measurements on the third and tenth days after surgery (p<0.05). The mean value of the SV group was higher than that of the MPP group on both days (Table 1).

After the analysis, a significant difference was observed in the VAS values measured on the first and third postoperative days (p<0.05). However, there was no intergroup difference in the initial opioid requirement and daily opioid consumption values (p>0.05). Regarding VAS values, the mean of the MPP group was higher than that of the SV group on both days (Table 2).

Table 3 presents the values of CPM endurance and passive ROM. Analyses revealed significant differences in CPM values (p<0.05). Specifically, in terms of endurance, the mean value of the SV group for CPM 1, 2, and 3 was higher than the mean value of the MPP group. Similarly, in terms of passive ROM, the mean value of the SV group for CPM 1, 2, and 3 was higher than the mean value of the MPP group (Table 3).

Table 3. CPM values in groups

The study groups were analyzed in terms of developing complications. According to the findings, no complications were observed in 136 participants in the MPP group and 129 participants in the SV group. Superficial soft tissue infections were seen in five participants in the MPP group and three in the

Table 1. KSS – knee, KSS – function and OKS findings in the study groups.

	Group	n	Mean	Standard Deviation	Z	p
KSS - Knee Pre Op	MPP	147	43,45	8,9	-0,068	0,946
	SV	141	43,05	9,972		
KSS - Knee Post Op 12th week	MPP	147	89,33	6,118	-1,15	0,25
	SV	141	90,27	4,658		
KSS - Knee Post Op 1st year	MPP	147	96,28	2,415	-1,952	0,051
	SV	141	97,01	1,713		
KSS - Func - Pre Op	MPP	147	43,42	12,518	-1,714	0,087
	SV	141	44,93	13,693		
KSS - Func - Post Op 12th week	MPP	147	88,61	7,576	-1,254	0,21
	SV	141	90	5,946		
KSS -Func - Post Op 1st year	MPP	147	95,44	2,862	-1,077	0,282
	SV	141	95,74	3,102		
OKS - Pre Op	MPP	147	11,03	4,272	-1,682	0,093
	SV	141	11,12	2,855		
OKS - Post Op 3rd day	MPP	147	15,48	4,139	-5,398	<0,001
	SV	141	17,66	3,288		
OKS - Post Op 10th day	MPP	147	23,16	4,776	-3,817	<0,001
	SV	141	25,39	5,054		
OKS - Post Op 12. Week	MPP	147	36,71	3,829	-0,336	0,737
	SV	141	36,85	3,732		
OKS - Post Op 1. Year	MPP	147	45,84	1,599	-1,375	0,169
	SV	141	45,57	1,546		

Table 2. VAS and Opioid values in study groups.

	Group	n	Mean	Standard Deviation	Z	p
VAS - Pre Op	MPP	147	8,94	1,136	-0,895	0,371
	SV	141	9,05	1,098		
VAS - Post Op 1st day	MPP	147	7,44	1,217	-4,541	<0,001
	SV	141	6,77	1,169		
VAS - Post Op 3rd day	MPP	147	5,69	1,423	-2,508	0,012
	SV	141	5,25	1,116		
VAS - Post Op 10th day	MPP	147	3,68	1,334	-1,079	0,281
	SV	141	3,47	1,099		
VAS - Post Op 12th week	MPP	147	1,76	0,857	-0,814	0,416
	SV	141	1,74	1,003		
VAS - Post Op 1st year	MPP	147	0,61	0,678	-0,217	0,828
	SV	141	0,64	0,73		
Initial Opioid Requirement	MPP	147	7,99	4,098	-0,836	0,403
	SV	141	7,71	4,522		
Opioid 1st day Consumption	MPP	147	1,33	0,538	-0,46	0,645
	SV	141	1,3	0,57		
Opioid 2nd day Consumption	MPP	147	1,17	0,847	-0,419	0,675
	SV	141	1,14	0,833		
Opioid 3rd day Consumption	MPP	147	0,75	0,766	-1,762	0,078
	SV	141	0,6	0,727		
Total Consumption	MPP	147	3,2449	1,90022	-0,902	0,367
	SV	141	3,0355	1,88001		

Table 3. CPM values in groups.

	Group	n	Mean	Standard Deviation	Z	p
CPM 1 – (Endurance)	MPP	147	51,16	14,852	-3,3	0,001
	SV	141	56,45	11,044		
CPM 1 - passive ROM	MPP	147	81,53	15,534	-5,125	<0,001
	SV	141	87,45	5,657		
CPM 2 - (Endurance)	MPP	147	52,52	11,155	-4,958	<0,001
	SV	141	58,33	8,776		
CPM 2 - passive ROM	MPP	147	95,34	13,34	-2,654	0,008
	SV	141	98,65	7,267		
CPM 3 - (Endurance)	MPP	147	50,14	15,648	-7,508	<0,001
	SV	141	60,6	9,363		
CPM 3 - passive ROM	MPP	147	97,93	24,424	-4,413	<0,001
	SV	141	105,67	9,529		

SV group, while the deep joint infection was observed in one participant in the SV group. No cases of deep joint infection were found in the MPP group. Six participants in the MPP group and eight in the SV group were reported to have developed hematomas. However, there was no statistically significant difference between the groups regarding complications ($p>0.05$).

Discussion

Our study's early three-month period results observed benefits of SV approach mainly in parameters such as early rehabilitation endurance and higher range of motion values. The more harmonious patellar tracking contributed to these results [8]. In the study conducted by Grace et al. [9], the incidence of medial tilt was found to be 8% in the MPP group and 2.5% in the SV group. An objective evaluation of patellar tilt and tracking was not performed in our study. Nevertheless, the clinical outcomes of the SV group support the findings in the literature.

In the literature, findings indicate that the SV approach is particularly successful in muscle strength and pain management following surgery. Faura et al. [12] reported no difference between the measurements of the SV and MPP approaches in quadriceps peak torque. In a study [13], the SV approach was significantly superior to other approaches regarding straight leg raises and pain management in the early postoperative period. Our study observed significant improvement in the SV approach group in endurance and passive ROM measurements using VAS and CPM modalities on the first, second, and third postoperative days.

The patella is supplied by an extraosseous vascular ring [14]. The supreme genicular artery lies in the belly of the vastus medialis and is preserved by the SV approach [7]. The MPP approach disrupts the relationship between the perivascular vascular ring and the superior, superomedial, and inferomedial genicular vessels. The SV approach is thought to reduce the need for lateral retinacular release and, thus, minimize the impact on patellar blood supply [14-16].

In the study [10], which evaluated early postoperative outcomes, it was emphasized that the values of the SV group recorded on the first day postoperatively in passive flexion were superior to those of the MPP group and that this difference was statistically significant. The measurements we made on the first, second, and third postoperative days showed that SV group values were significantly better in both aspects. With respect to ROM, SV group values were significantly higher than MPP group values in measurements taken on the third and tenth postoperative days. However, the difference identified in measurements taken during the twelfth week and the first year was not statistically significant. Passive flexion of the knee joint is controversial, as it is influenced by many parameters, such as component alignment and patellar alignment [17-19].

When comparing the SV and MPP approaches in total knee arthroplasty, differences existed between flexion and extension during early rehabilitation. The SV group observed passive and active straight leg raising earlier [10]. However, our study did not evaluate an objective parameter measuring active extension.

Faure et al. [12] reported no difference in quadriceps muscle strength three months after total knee arthroplasty. However, in the first week and first month postoperatively, muscle strength was significantly higher in the SV group compared to the MPP group. However, no differences were found in VAS values between the groups on the 10th day and after. Our findings suggest that muscle strength is regained earlier in the SV approach and that postoperative pain is less on the first and third days compared to the MPP approach.

There is a consensus in the literature regarding the superiority of the SV approach in the early period. However, this finding loses its validity after the third month, which can be explained by the quadriceps tendon's healing and the extensor mechanism's normalization [20]. In our study, it was observed that there was no superiority of the SV approach in terms of functional scores and active knee extension after the third month.

The results of KSS and OKS evaluations were the same as the other parameters. According to the measurements taken on the 10th postoperative day, OKS values were significantly higher in the SV group. However, no difference was found between the groups in OKS and KSS evaluations after the 12th week.

In VAS analyses, a significant superiority was observed in the SV group in measurements taken on the first, second, and third postoperative days. However, the VAS values of both groups were similar after the 10th day. Although the SV group had a better first opioid requirement time and daily consumption, no statistically significant difference was found between the groups.

Berstock et al. conducted a meta-analysis by examining 11 studies [21]. The results showed that the SV group had better VAS values on the first day and ROM values on the first week. These results were statistically significant. However, no significant difference was observed in the KSS values among the examined studies, consistent with our findings. Our study found that the OKS values in the SV group were significantly better on the third- and tenth days post-surgery. However, no significant difference was observed in subsequent follow-ups.

Different results have been reported in the literature regarding complications. Peng et al. found that SV and MPP groups were similar regarding soft tissue and wound complications [22]. Li et al. found that wound healing was worse in the SV group, but there was no difference in a hematoma [23]. Our study showed that hematoma was more common, and wound healing was worse in the SV group.

The SV approach in TKR offers advantages; however, there are unpredictable perioperative challenges [24, 25]. The main issue is the difficulty and insufficiency of the visual field during surgery, which is challenging to predict preoperatively. Obesity, muscle hypertrophy, and failed proximal tibial osteotomy further complicate the SV approach [8]. We suggest avoiding the SV approach in fixed knees with advanced joint contracture, large patellar osteophytes, and severe varus deformities. The occurrence of the secondary patellar tendon and medial collateral ligament injuries is probable. These injuries are particularly associated with advanced deformation and challenging dislocation, especially during the early stages of the learning curve.

Our study has some limitations. One limitation is the retrospective design, which can disrupt randomization in patient selection and homogeneity of results. Another limitation is the

one-year limit on patient follow-up. Therefore, a randomized controlled cohort study will be planned to reevaluate the results.

Conclusion

Our study concluded that the SV approach should not be the first choice for TKR due to its limitations in surgical visualization and longer learning curve. The MPP approach should be preferred for TKR because it provides a more comprehensive surgical view, an easy learning curve, and lower complication rates.

Acknowledgments: We would like to thank H. Cagdas Basat and O Utku Demir for their contributions.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Funding: *None*

Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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How to cite this article:

Mehmet Fevzi Cakmak, Levent Horoz. *Could the subvastus approach be the first choice in total knee arthroplasty? Ann Clin Anal Med 2023;14(11):1006-1010*

This study was approved by the Ethics Committee of Kirsehir Ahi Evran University (Date: 2023-03-07, No: 2023-05/30)